Unit 1 – Semiconductors

Q1. Define Semiconductor and Enlist the Properties of Semiconductor. (4)

PAGE NO.:
DATE: / /

What is semi-conductor

⇒ Semiconductor is a substance which has resistivity (10^{-4} to $0.5\ \Omega m$) inbetween conductors and insulators. e.g. germanium, silicon, selenium, carbon, etc.

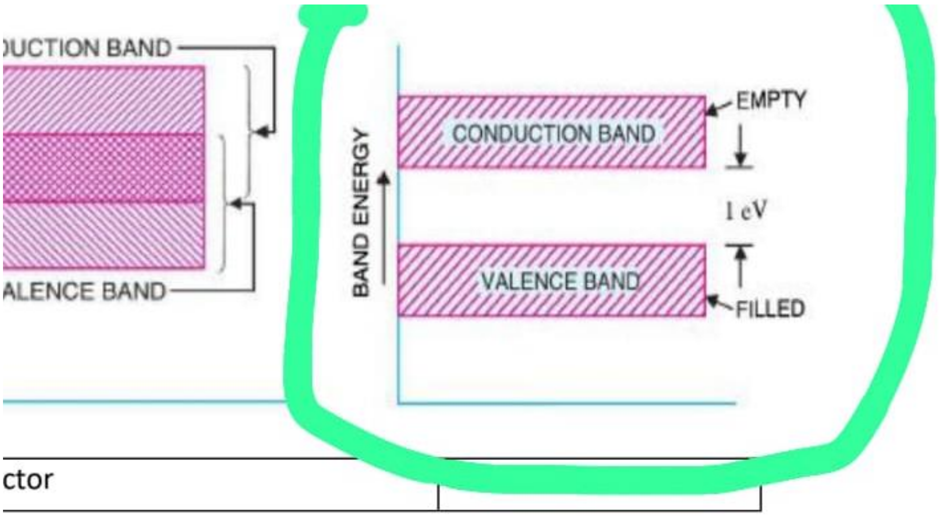
* Properties of Semiconductor

(i) The restivity of a semiconductor is less than an insulator but more than a conductor.

(ii) Semiconductor has negative temperature coefficient of resistance

(iii) When suitable metallic impurities (e.g. arsenic, gallium, etc) is added to a semiconductor, its current conducting properties change appreciably. ~~This~~ ~~Pro~~ The process of adding the metallic impurities is called doping.

Q2. Give the energy band description of semiconductors.(4)



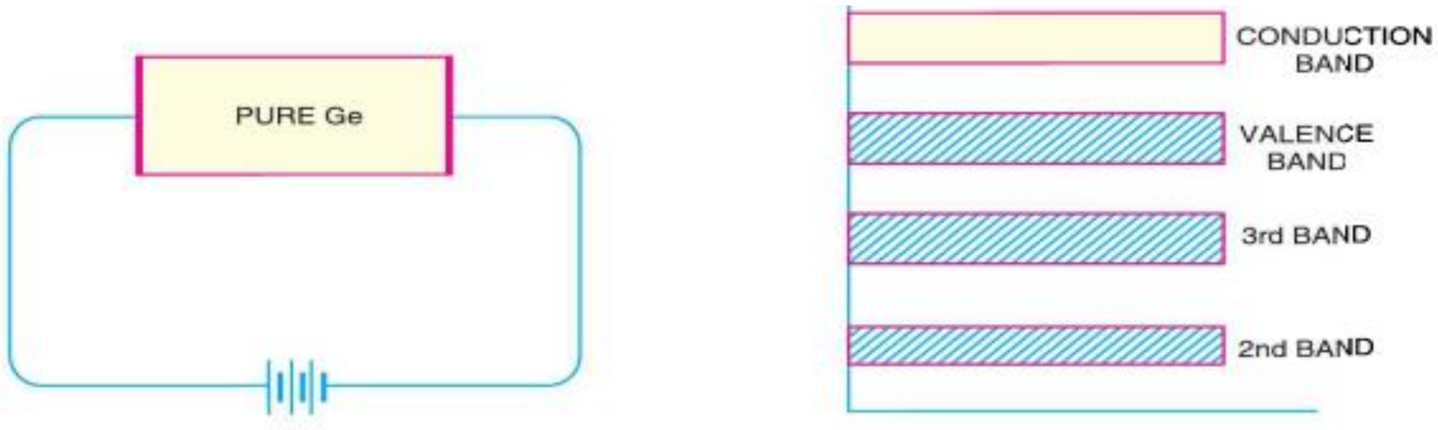
(iii) **Semicondutors.** Semiconductors (*e.g.* germanium, silicon etc.) are those substances whose electrical conductivity lies inbetween conductors and insulators. In terms of energy band, the valence band is almost filled and conduction band is almost empty. Further, the energy gap between valence and conduction bands is very small as shown in Fig. 4.7. Therefore,

Q3. Describe the effect of temperature on semiconductors. (4/6)

5.6 Effect of Temperature on Semiconductors

The electrical conductivity of a semiconductor changes appreciably with temperature variations. This is a very important point to keep in mind.

(*i*) At absolute zero. At absolute zero temperature, all the electrons are tightly held by the semiconductor atoms. The inner orbit electrons are bound whereas the valence electrons are engaged in co-valent bonding. At this temperature, the co-valent bonds are very strong and there are no free electrons. Therefore, the semiconductor crystal behaves as a perfect insulator [See Fig. 5.6 (*i*)].

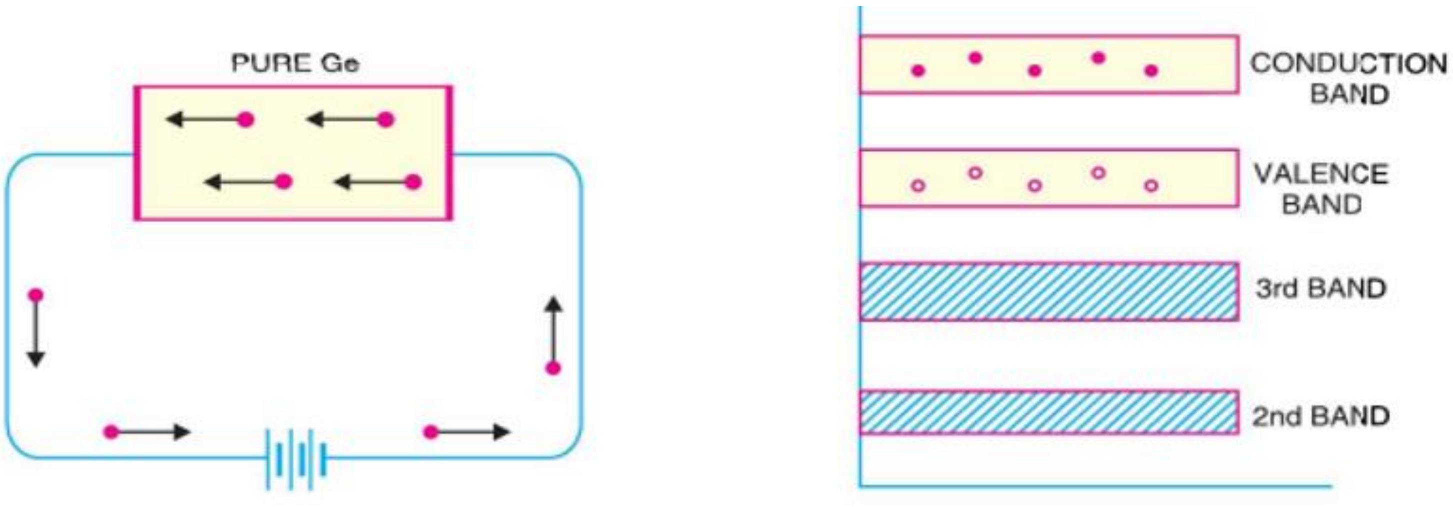


(*i*) (*ii*)

Fig. 5.6

(*ii*) Above absolute zero. When the temperature is raised, some of the covalent bonds in the semiconductor break due to the thermal energy supplied. The breaking of bonds sets those electrons *free* which are engaged in the formation of these bonds. The result is that a few free electrons exist in the semiconductor. These free electrons can constitute a tiny electric current if potential difference is

applied across the semiconductor crystal [See Fig. 5.7 (*i*)]. *This shows that the resistance of a semi-conductor decreases with the rise in temperature i.e.* it has negative temperature coefficient of resistance. It may be added that at room temperature, current through a semiconductor is too small to be of any practical value.



(*i*) (*ii*)

Fig. 5.7

Q4. Differentiate between Extrinsic and Intrinsic semiconductors.(4)

Point of Difference	Intrinsic Semiconductor	Extrinsic Semiconductor
Definition	A pure form of semiconductor without any added impurity.	A semiconductor doped with a small amount of impurity to improve conductivity.
Conductivity	Poor conductivity at room temperature.	Improved conductivity due to presence of free charge carriers from dopants.
Charge Carriers	Equal number of electrons and holes.	Electrons or holes are majority carriers depending on doping (n-type or p-type).
Carrier Generation	Carriers are thermally generated.	Carriers come mainly from dopant atoms.
Doping	No doping; 100% pure.	Doped with group III or group V elements.
Types	Only one type – pure semiconductor.	Two types: n-type and p-type.
Examples	Pure silicon, pure germanium.	Silicon doped with phosphorus (n-type) or boron (p-type).

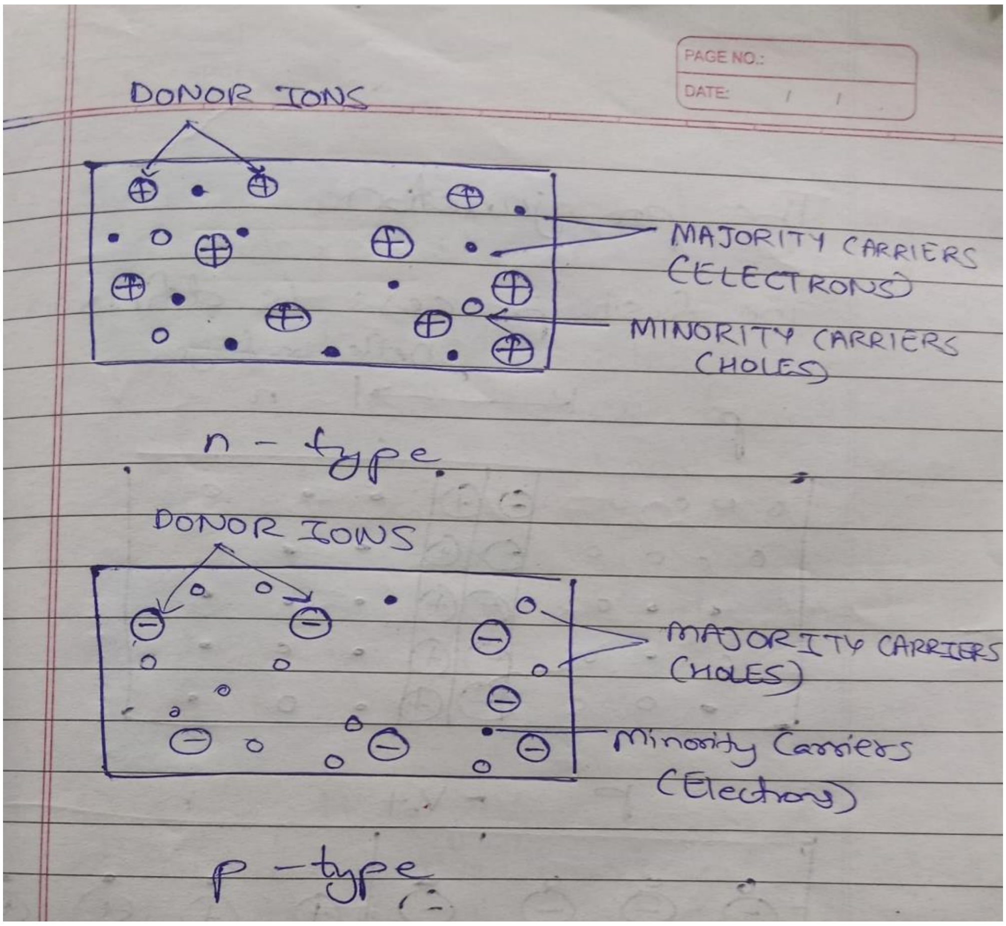
Q5. Explain with neat diagram N-type and P-type semiconductors. (4/6/8)

N-type

- Valence electrons: 5 e^-
- **Pentavalent impurities added**
  e.g. Arsenic (33), Antimony (51)
- **Donor impurities**
- **Majority carrier are e^-**
- **Negative (N) type semiconductors**

P-type

- Valence electrons: 3 e^-
- **Trivalent impurities added**
  e.g. Gallium (31), Indium (49)
- **Acceptor impurities**
- **Majority carrier are holes**
- **Positive (P) type semiconductors**



Q6. Compare P and N type Semiconductor. (4/6)

Extrinsic Semiconductor Types

N type (valence 5 e^-)	P type
Pentavalent impurities added	Trivalent impurities
e.g. Arsenic (33), Antimony (51)	Gallium (31), Indium (49)
Donar impurities	Acceptor impurities
Majority carrier are e^-s	Majority carrier are holes
Negative (N) type Semi-conductor	Positive (P) type semi-conductor

Q7. Explain the formation of PN junction. (4/6)

PAGE NO.:
DATE: / /

Step-1
* When p type and n type join together, the electrons from n type starts moving towards the holes in p type, and holes from p type starts moving towards the electrons in n type. This process of ~~moving~~ ~~of~~ movement of electrons and holes is called diffussion.

Step-2
* During the process of diffusion, the ions associated with electrons and holes are uncovered.

Step-3
* This ions starts accumulating towards the junction.

Step-4
* This creates a layer of ion at the junction. This region is called as depletion region which stops the further diffusion of electrons and holes.

PAGE NO.:
DATE: / /

Step-5
* Their exists the potential difference accross the depletion layer / region and is called as Potential Barrier (V_o)

$V_o = 0.7$ V (For Silicon)

$V_o = 0.3$ V (For Germanium)

Q8. Define: 1) Diffusion 2) Potential barrier 3) Depletion Region. (4/6)

The answers for this question are given from Q.7 the answer are from following steps

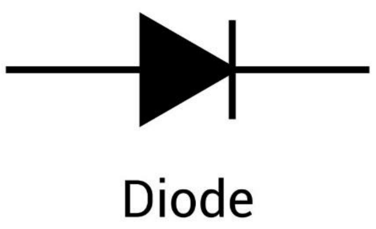
1]Diffusion: Step 1
2] Potential barrier: Step5
3] Depletion Region: Step 4

Q9. Define Diode, draw its Symbol and write its application. (4)

Define:

Diode allows current to flow in one direction, while blocking it in the opposite direction. Diode also converts alternating current (AC) to direct current (DC).

Symbol:



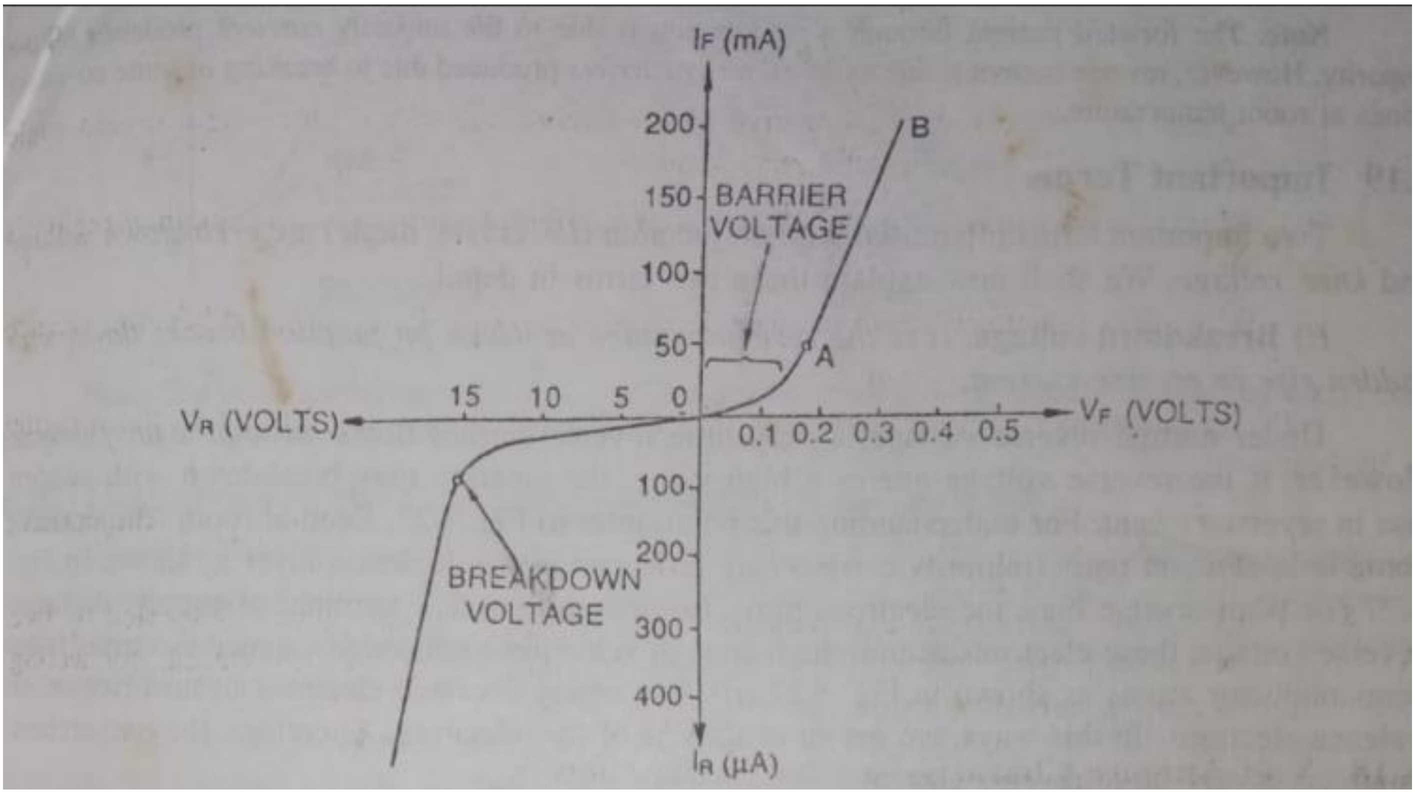
Applications:

- Rectifier
- Voltage Regulator
- LCD
- LED

Q10. With neat diagram explain VI characteristics of Diode. (6)

Characteristics of a Diode (V-I Characteristics):

1. **Forward Bias Region:**
   - When the positive terminal of the power supply is connected to the anode and the negative terminal to the cathode, the diode is forward biased.
   - In this condition, the diode allows current to flow easily once a threshold voltage (typically 0.7V for silicon diodes) is reached.
   - Below the threshold voltage, only a small leakage current flows, which is negligible.
   - As the forward voltage increases beyond the threshold, the current increases sharply, following an exponential rise.
2. **Reverse Bias Region:**
   - When the anode is connected to the negative terminal and the cathode to the positive terminal of the power supply, the diode is reverse biased.
   - In this condition, ideally, no current flows through the diode (except for a very small reverse saturation current).
   - If the reverse voltage exceeds the breakdown voltage (e.g., 100V for a typical diode), the diode enters a breakdown region, and a large current starts flowing, which may damage the diode.
3. **Breakdown Region:**
   - In reverse bias, if the voltage reaches a certain critical value (reverse breakdown voltage), the diode undergoes breakdown.
   - In this region, the current increases rapidly with little increase in voltage.
   - The diode may be permanently damaged if the current is not limited (in the case of a Zener diode, this is used for voltage regulation).



Q11. With neat circuit diagram explain working of PN junction in Forward and Reverse bias. (6)

Forward biasing:

When external voltage applied to the junction is in such a direction that it cancels the potential barrier, thus permitting current flow, it is called forward biasing.

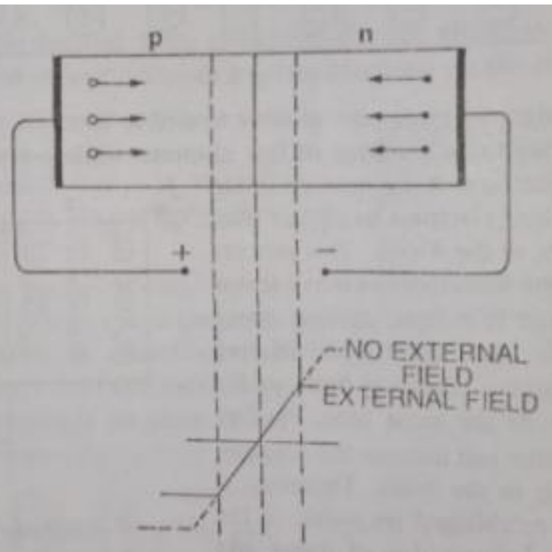


Fig. 8.21

(i) The potential barrier is reduced and at some forward voltage (0.1 to 0.3V), it is eliminated altogether.

(ii) The junction offers low resistance (called *forward resistance*, R_f) to current flow.

(iii) Current flows in the circuit due to the establishment of low resistance path. The magnitude of current depends upon the applied forward voltage.

Reverse biasing:

When the external voltage applied to the junction is in such a direction that potential barrier is increased, it is called reverse biasing.

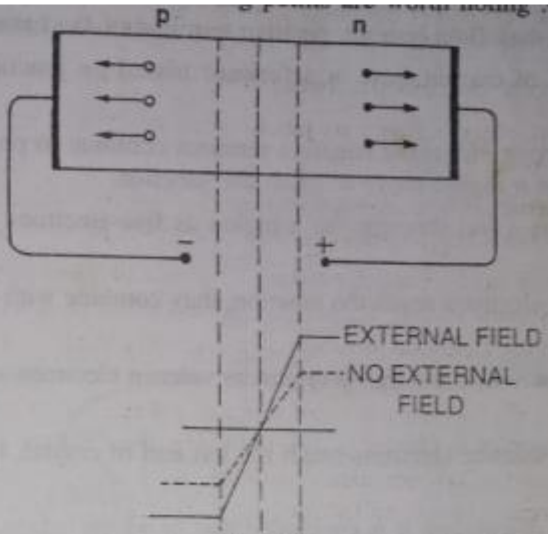


Fig. 8.22

(i) The potential barrier is increased.

(ii) The junction offers very high resistance (called *reverse resistance* R_r) to current flow.

(iii) No current flows in the circuit due to the establishment of high resistance path.

Q12. Define Zener diode and list its properties. (4/6)

(i) Zener Diode :- A properly doped crystal diode which has a sharp breakdown voltage is known as a zener diode

PAGE NO.:
DATE: / /

Properties :-

(1) is like an ordinary diode except that it is properly doped to have a sharp breakdown voltage

(2) Zener diode is always reverse connected.

(3) Sharp breakdown voltage is called zener voltage V_z

(4) When it is FB it shows the same characteristics as the normal diode.

(5) It does not get burnt easily as it is already in the breakdown region.

Application:- It is used as a voltage regulator.

Q13. Explain with neat diagram the VI Characteristics of Zener diode. (6/8)

V-I Characteristics of Zener Diode

A **Zener diode** is a special type of diode designed to operate in the **reverse breakdown region**. The V-I characteristics of a Zener diode show how it behaves in both forward and reverse bias conditions.

1. Forward Bias Region:

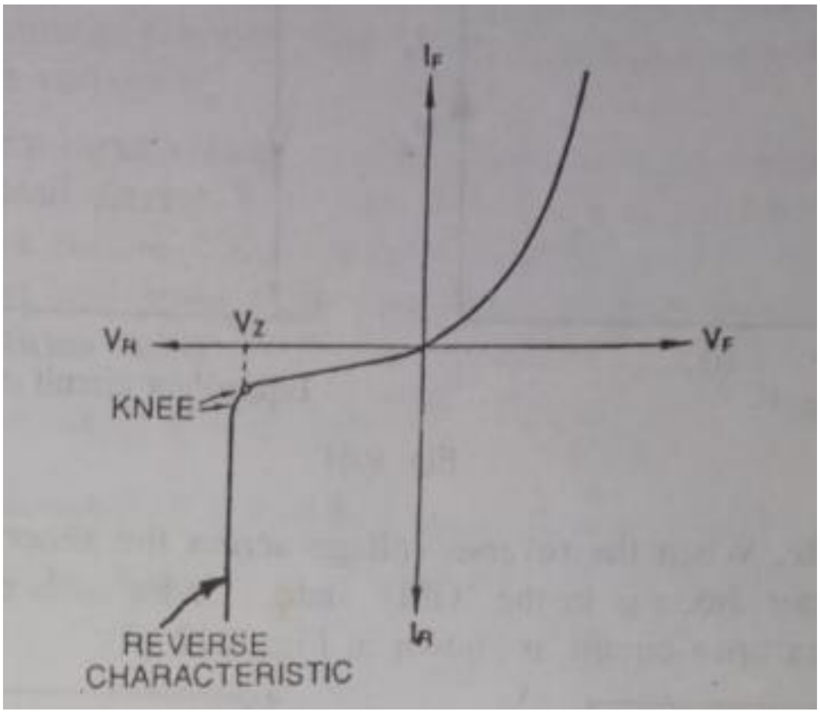
- In forward bias (anode connected to positive terminal), the Zener diode behaves like a normal p-n junction diode.
- A small forward voltage (~0.7V for silicon) is needed for it to conduct.
- Once this threshold is crossed, current increases rapidly with voltage.

2. Reverse Bias Region:

- In reverse bias (anode connected to negative terminal), a small reverse leakage current flows until the reverse voltage reaches a certain value called the **Zener Breakdown Voltage (Vz)**.
- At this point, the diode starts conducting heavily in reverse direction.
- The voltage across the diode remains **almost constant at Vz**, even if the reverse current increases.
- This region is called the **Zener breakdown region**, and is used for **voltage regulation** in electronic circuits.

Important Points:

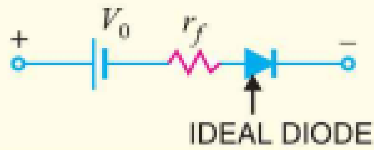
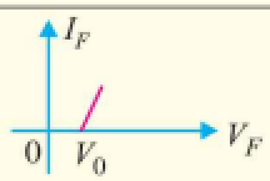
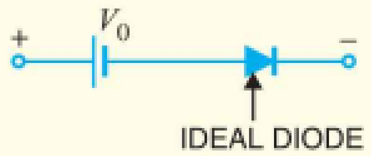
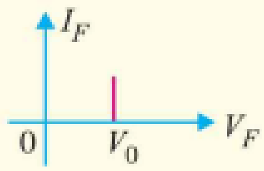
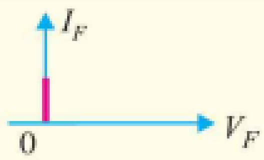
- **Breakdown voltage (Vz)** is the critical voltage where the Zener effect occurs.
- Zener diodes are available with different Vz values (e.g., 5.1V, 6.2V, etc.).
- In breakdown region, Zener diode maintains a **constant output voltage** despite changes in input voltage or load current.



Q14. Draw the symbol of crystal diode with equivalent Circuits. (4)

6.5 Crystal Diode Equivalent Circuits

It is desirable to sum up the various models of crystal diode equivalent circuit in the tabular form given below:

S.No.	Type	Model	Characteristic
1.	Approximate model		
2.	Simplified model		
3.	Ideal Model		

Unit 2 – Applications of Semiconductors (Rectifiers, Devices)

Q1. Define the following terms: PIV, Knee voltage, Breakdown voltage. (4/6)

2) Peak inverse Voltage.

⇒ It is ~~the~~ a maximum reverse voltage that a diode can withstand without destroying the junction.
Ex:- value varries between 10V to 10kV depending upon the type of diode.

PAGE NO.:
DATE: / /

Knee Voltage :- It is a forward voltage at which current through the junction starts increasing rapidly.

⊙ Breakdown voltage :- It is a minimum reverse voltage at which the pn junction breakdown with sudden rise in reverse current.

Q2. Describe a half-wave rectifier using a crystal diode. (4/6)

half-cycles, no current is conducted and hence no voltage appears across the load. Therefore, current always flows in one direction (*i.e.* d.c.) through the load though after every half-cycle.

Circuit details. Fig. 9.16 shows the circuit where a single crystal diode acts as a half-wave rectifier. The a.c. supply to be rectified is applied in series with the diode and load resistance R_L. Generally, a.c. supply is given through a transformer. The use of transformer permits two advantages. Firstly, it allows us to step up or step down the a.c. input voltage as the situation demands. Secondly, the transformer isolates the rectifier circuit from power line and thus reduces the risk of electric shock.

Operation. The a.c. voltage across the secondary winding *AB* changes polarities after every half-cycle. During the positive half-cycle of input a.c. voltage, end *A* becomes positive *w.r.t.* end *B*. This makes the diode forward biased and hence it conducts current. During the negative half-cycle, end *A* is negative *w.r.t.* end *B*. Under this condition, the diode is reverse biased and it conducts no current,. Therefore, current flows through the diode during positive half-cycles of input a.c. voltage only ; it is blocked during the negative half-cycles [see Fig. 9.16 (*ii*)]. In this way, current flows through load R_L always in the same direction. Hence d.c. output is obtained across R_L. It may be noted that output across the load is pulsating d.c. These pulsations in the output are further smoothened with the help of *filter circuits* discussed later.

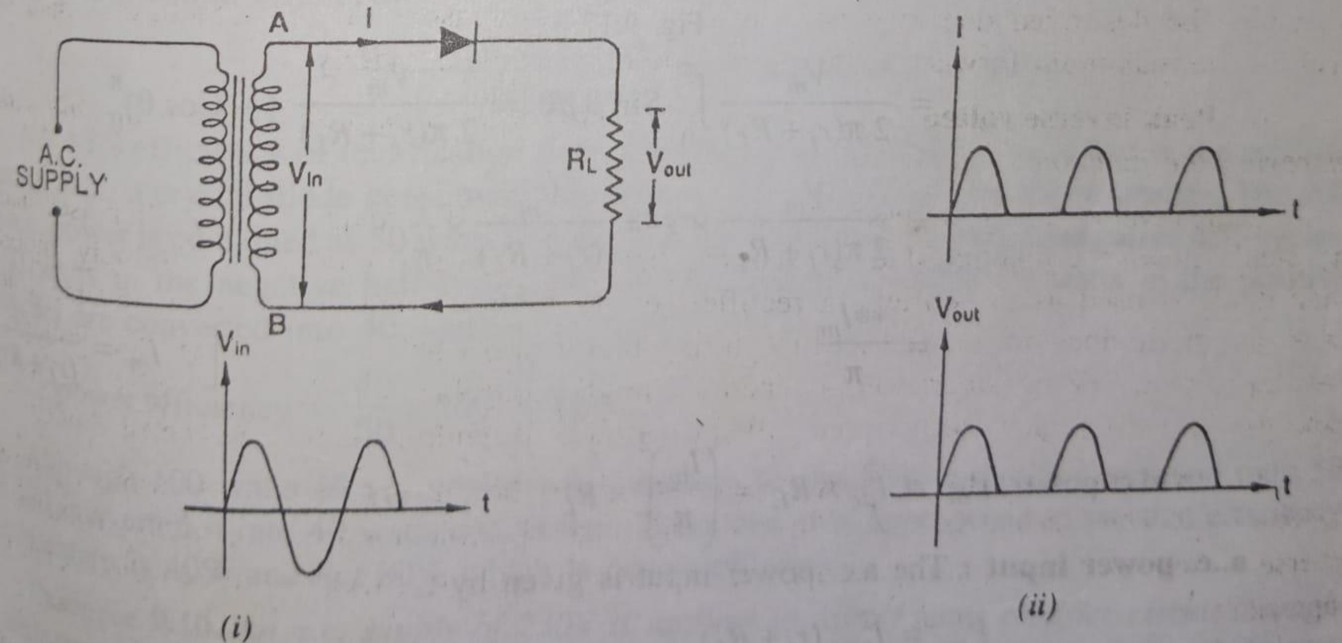


Fig. 9.16

Q3. Explain the working of Centre-tap full-wave rectifier with neat diagram. (6/8)

9.10 Centre-Tap Full-Wave Rectifier

The circuit employs two diodes D_1 and D_2 as shown in Fig. 9.19. A centre tapped secondary winding *AB* is used with two diodes connected so that each uses one half-cycle of input a.c. voltage. In other words, diode D_1 utilises the a.c. voltage appearing across the upper half (*OA*) of secondary winding for rectification while diode D_2 uses the lower half winding *OB*.

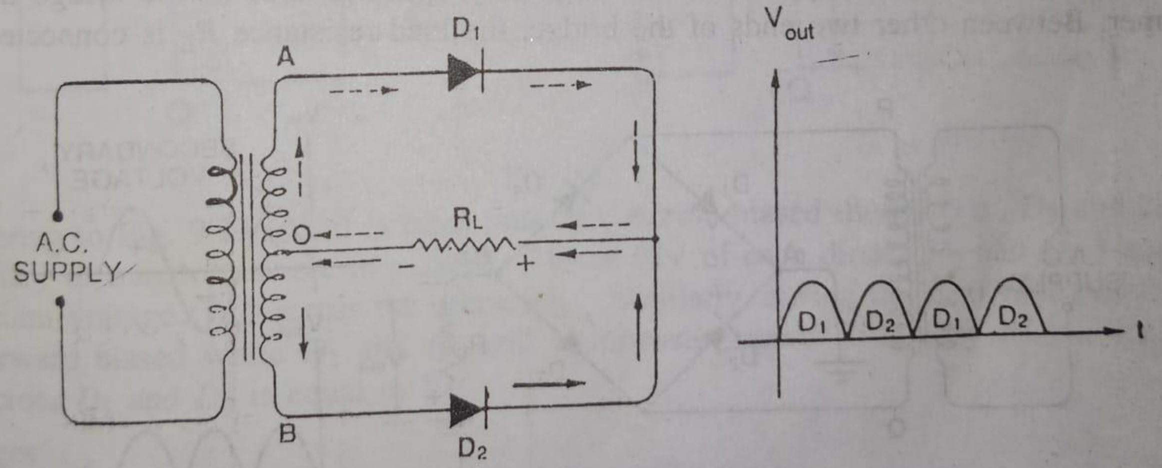


Fig. 9.19

Operation. During the positive half-cycle of secondary voltage, the end *A* of the secondary winding becomes positive and end *B* negative. This makes the diode D_1 forward biased and diode D_2 reverse biased. Therefore diode D_1 conducts while diode D_2 does not. The conventional current flow is through diode D_1, load resistor R_L and the upper half of secondary winding as shown by the dotted arrows. During the negative half-cycle, end *A* of the secondary winding becomes negative and end *B* positive. Therefore, diode D_2 conducts while diode D_1 does not. The conventional current flow is through diode D_2, load R_L and lower half winding as shown by solid arrows. Referring to Fig. 9.19, it may be seen that current in the load R_L is *in the same direction* for both half-cycles of input a.c. voltage. Therefore, d.c. is obtained across the load R_L. Also, the polarities of the d.c. output across the load should be noted.

Q4. Explain the working of Full-wave bridge rectifier with neat diagram. (6/8)

9.11 Full-Wave Bridge Rectifier

The need for a centre tapped power transformer is eliminated in the bridge rectifier. It contains four diodes D_1, D_2, D_3 and D_4 connected to form bridge as shown in Fig. 9.21. The a.c. supply to be rectified is applied to the diagonally opposite ends of the bridge through the transformer. Between other two ends of the bridge, the load resistance R_L is connected.

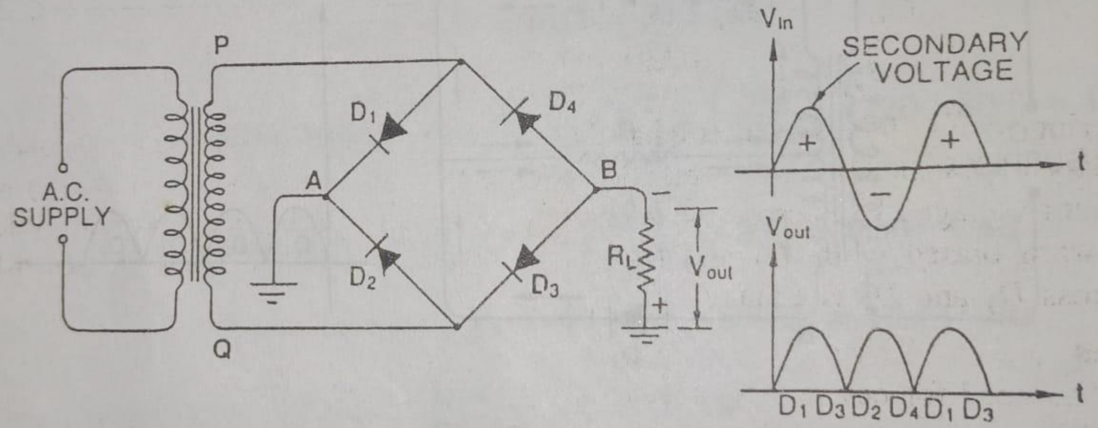


Fig. 9.21

Operation. During the positive half-cycle of secondary voltage, the end P of the secondary winding becomes positive and end Q negative. This makes diodes D_1 and D_3 forward biased while diodes D_2 and D_4 are reverse biased. Therefore, only diodes D_1 and D_3 conduct. These two diodes will be in series through the load R_L as shown in Fig. 9.22 *(i)*. The conventional current flow is shown by dotted arrows. It may be seen that current flows from A to B through the load R_L.

During the negative half-cycle of secondary voltage, end P becomes negative and end Q positive. This makes diodes D_2 and D_4 forward biased whereas diodes D_1 and D_3 are reverse biased. Therefore, only diodes D_2 and D_4 conduct. These two diodes will be in series through the load R_L as shown in Fig. 9.22 *(ii)*. The current flow is shown by the solid arrows. It may be seen that again current flows from A to B through the load *i.e.* in the same direction as for the positive half-cycle. Therefore, d.c. output is obtained across load R_L.

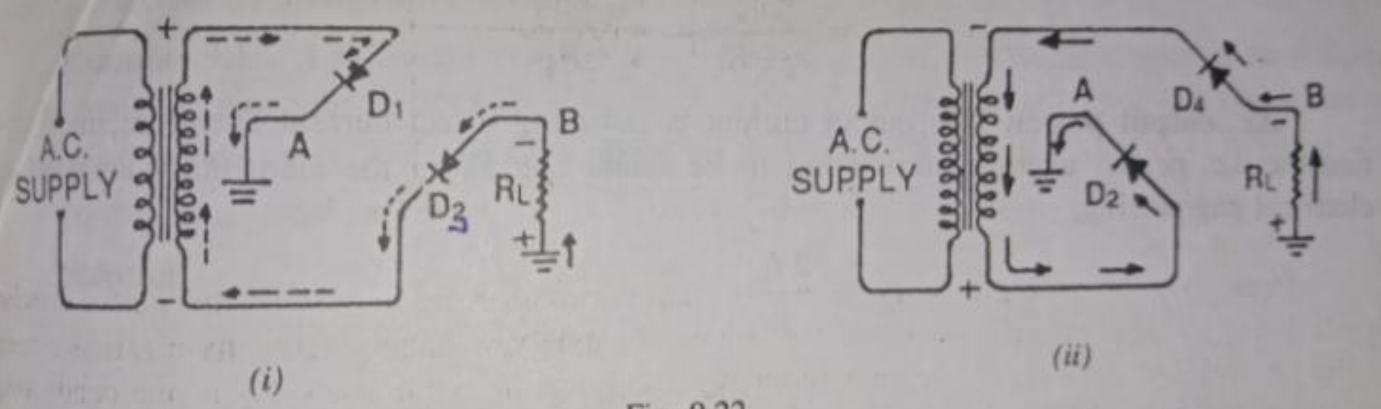


Fig. 9.22

Q5. Define Ripple Factor. Give the value of R.F for half wave and Full wave rectifier. (4)

The ratio of r.m.s. value of a.c. component to the d.c. component in the rectifier output is known as **ripple factor** *i.e.*

$$\text{Ripple factor} = \frac{\text{r.m.s. value of a.c. component}}{\text{value of d.c. component}} = \frac{I_{ac}}{I_{dc}}$$

But I_{ac}/I_{dc} is the ripple factor.

$$\text{Ripple factor} = \frac{1}{I_{dc}}\sqrt{I_{rms}^2 - I_{dc}^2} = \sqrt{\left(\frac{I_{rms}}{I_{dc}}\right)^2 - 1}$$

(i) **For half-wave rectification.** In half-wave rectification,

$$I_{rms} = I_m/2 \quad ; \quad I_{dc} = I_m/\pi$$

$$\text{Ripple factor} = \sqrt{\left(\frac{I_m/2}{I_m/\pi}\right)^2 - 1} = 1.21$$

$\sqrt{\left(\frac{3.14}{2}\right)^2 - 1}$

It is clear that a.c. component exceeds the d.c. component in the output of a half-wave rectifier. This results in greater pulsations in the output. Therefore, half-wave rectifier is ineffective for conversion of a.c. into d.c.

(ii) **For full-wave rectification.** In full-wave rectification,

$$I_{rms} = \frac{I_m}{\sqrt{2}}; \quad I_{dc} = \frac{2I_m}{\pi}$$

$\sqrt{\left(\frac{3.14}{2\times\sqrt{2}}\right)^2 - 1}$

$$\therefore \quad \text{Ripple factor} = \sqrt{\left(\frac{I_m/\sqrt{2}}{2I_m/\pi}\right)^2 - 1} = 0.48$$

i.e. $\dfrac{\text{effective a.c. component}}{\text{d.c. component}} = 0.48$

Q6. Define: 1) Rectifier efficiency 2) Ripple factor.(4)

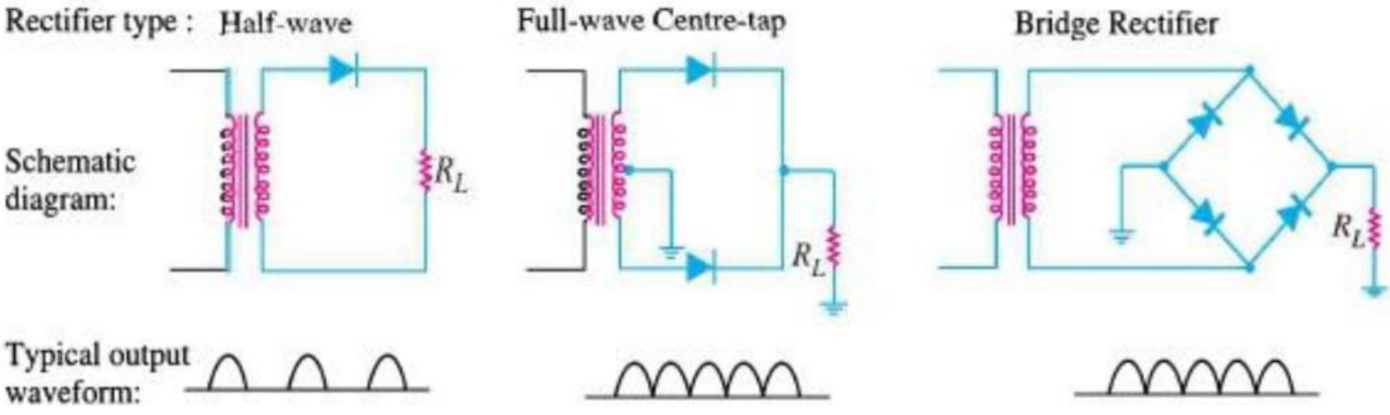
∴ Rectifier efficiency $= \dfrac{\text{d.c. output power}}{\text{a.c. input power}}$

The ratio of r.m.s. value of a.c. component to the d.c. component in the rectifier output is known as **ripple factor** *i.e.*

$$\text{Ripple factor} = \frac{\text{r.m.s. value of a.c. component}}{\text{value of d.c. component}} = \frac{I_{ac}}{I_{dc}}$$

Q7. Compare half-wave rectifier with Centre-tap full-wave and Full-wave bridge rectifier. (8)

6.19 Comparison of Rectifiers



S. No.	Particulars	Half-wave	Centre-tap	Bridge type
1	No. of diodes	1	2	4
2	Transformer necessary	no	yes	no
3	Max. efficiency	40.6%	81.2%	81.2%
4	Ripple factor	1.21	0.48	0.48
5	Output frequency	f_{in}	$2f_{in}$	$2f_{in}$
6	Peak inverse voltage	V_m	$2V_m$	V_m

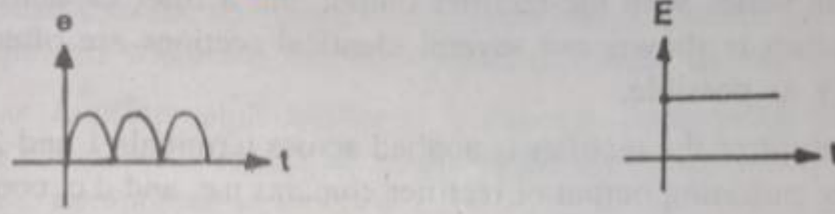
Note also other points we have discussed in class room

Q8. Define the following terms: a) Ripple Factor b) Filter circuits. (4)

The ratio of r.m.s. value of a.c. component to the d.c. component in the rectifier output is known as **ripple factor** *i.e.*

$$\text{Ripple factor} = \frac{\text{r.m.s. value of a.c. component}}{\text{value of d.c. component}} = \frac{I_{ac}}{I_{dc}}$$

A filter circuit *is a device which removes the a.c. component of rectifier output but allows the d.c. component to reach the load.*



Q9. Explain the working principle of Capacitor Filter. (4)

A capacitor filter is used in rectifier circuits to convert pulsating DC into a smoother DC output. It consists of a capacitor C connected in parallel with the load resistor R_L.

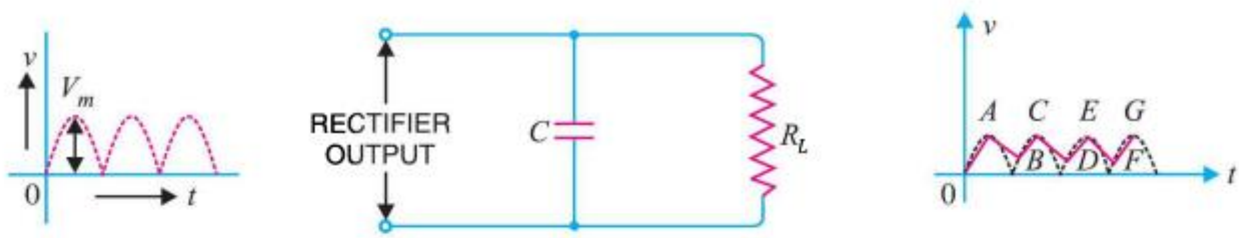
When the rectifier provides voltage, the capacitor charges up to the peak value V_m of the rectifier output. As the rectifier voltage drops after reaching its peak, the capacitor begins to discharge through the load resistor R_L, supplying current to the load.

This discharge is slow, so the voltage across the load decreases only slightly. When the next voltage peak arrives, the capacitor quickly recharges back to the peak value. This charging and discharging process repeats continuously.

As a result, the output voltage remains close to the peak value with very little ripple. The output waveform becomes nearly steady, and the capacitor filter effectively smooths the rectified voltage.

Key Points:

- The capacitor offers infinite reactance to DC, so it blocks DC.
- It charges when the rectifier voltage increases and discharges when it decreases.
- This results in a smooth and steady DC output with reduced ripple.



(i) (ii) (iii)

Q10. Explain the working principle of Choke input Filter. (4/6)

A choke input filter is used to smoothen the pulsating DC output of a rectifier. It consists of a **choke (inductor) L** connected in series with the rectifier output and a **capacitor C** connected in parallel with the load.

The output of a rectifier contains both AC and DC components. The **choke** offers **high opposition to AC** (due to high reactance) and **very low opposition to DC**. As a result, the **AC component is blocked**, while the **DC component passes** through the choke to the load.

At the same time, the **capacitor** connected across the load provides **low reactance to AC** and **high reactance to DC**. So, it **bypasses the remaining AC component**, preventing it from reaching the load.

Thus, the choke and capacitor together **filter out the AC component**, allowing only a smooth **DC output** to reach the load. The output voltage becomes more stable with significantly **reduced ripples.**

Key Points:

- **Choke blocks AC but passes DC.**
- **Capacitor bypasses AC to ground** but blocks DC.
- Result: Only **DC reaches the load**, giving a smooth output.

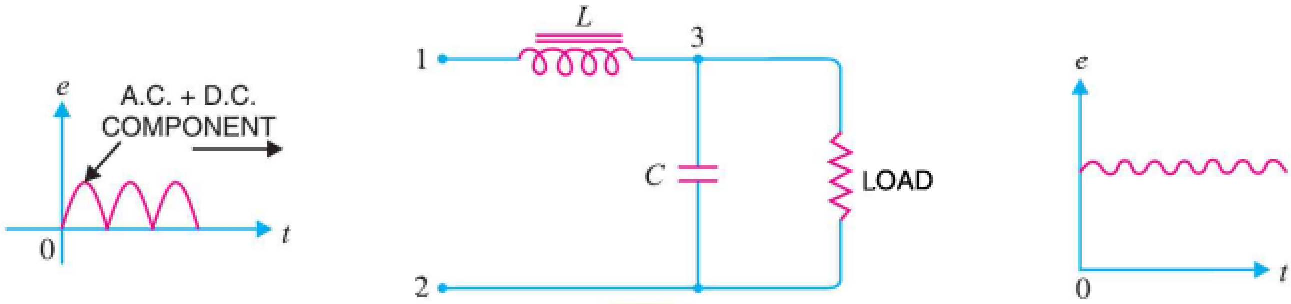


Fig. 6.42

Q11. Explain the working principle of Capacitor input Filter. (4/6)

A capacitor input filter or π-filter is used to smoothen the output of a rectifier. It consists of two capacitors (**C_1 and C_2**) and a choke (**L**) connected in a way that the circuit resembles the Greek letter π (pi).

- **C_1** is connected across the rectifier output.
- **L** (inductor) is connected in series.
- **C_2** is connected across the load.

This filter works by using the different properties of capacitors and inductors to block the unwanted **AC component** and allow the **DC component** to pass through.

Working:

1. **Capacitor C_1:**
   It offers **low reactance to AC** and **high reactance to DC.**
   So, it **bypasses most of the AC component** to ground, allowing only DC to move forward.
2. **Choke L:**
   It offers **high reactance to AC** and **low reactance to DC.**
   So, it **blocks any remaining AC** and allows **DC to flow** to the next stage.
3. **Capacitor C_2:**
   It further **bypasses any AC component** that may have passed through the choke, giving a **pure DC output** to the load.

The π-filter significantly **reduces ripples** in the rectifier output and provides a **smooth DC voltage** to the load. Multiple π-filter sections can be connected for even better filtering.

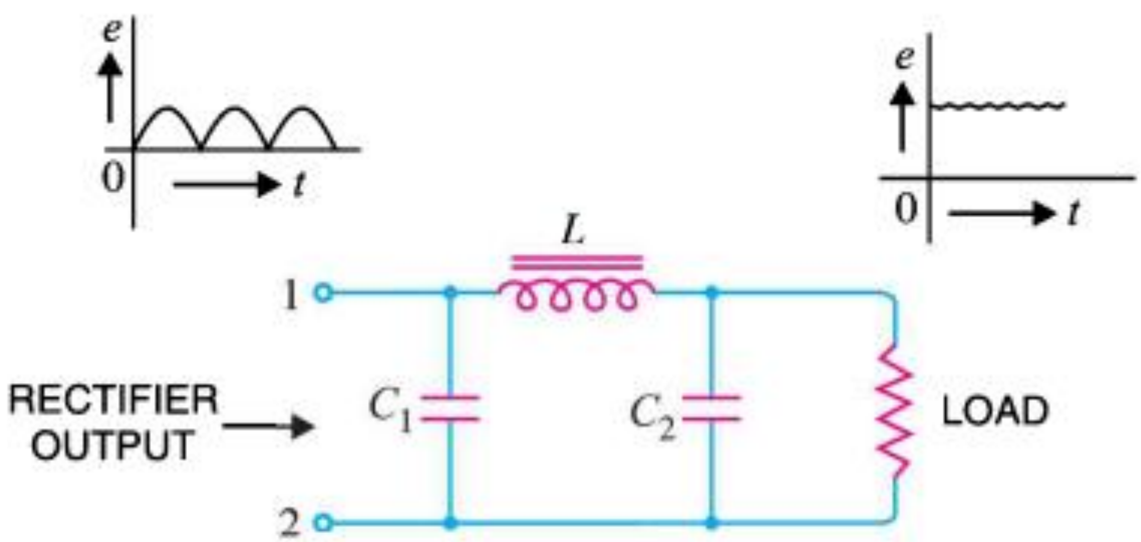


Fig. 6.43

Q12. Give the classification of Photoelectric devices.(4)

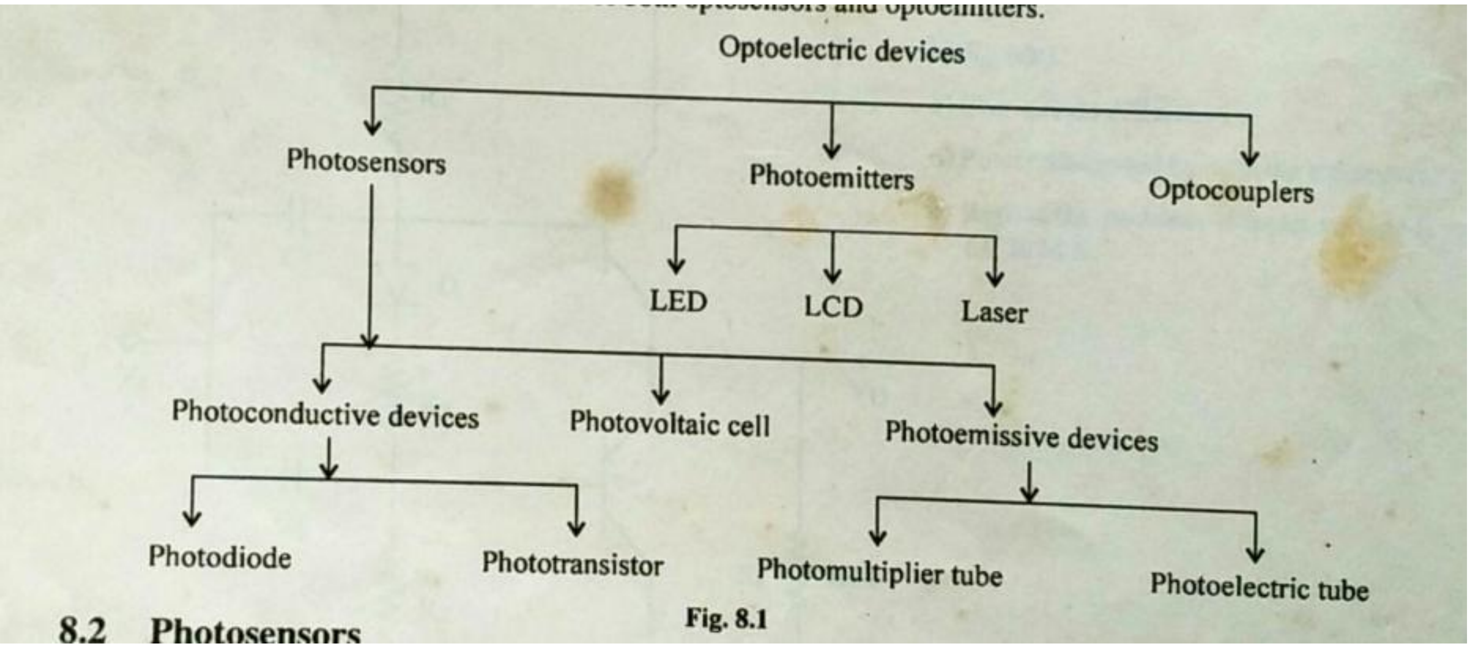


Fig. 8.1

Q13. Explain working of LED with help of diagram and Characteristics. (4/6)

Light Emitting Diode (LED)

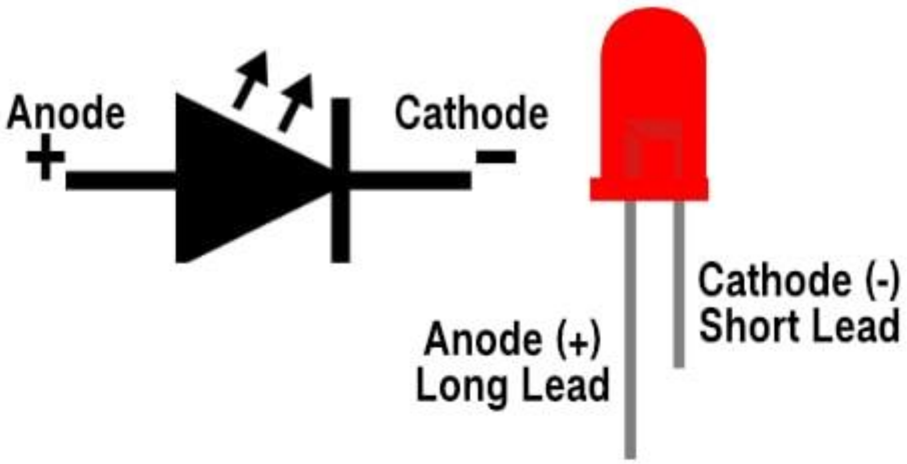
A **Light Emitting Diode (LED)** is a semiconductor device that emits **visible light** when **forward biased**.

Working:

- When the LED is forward biased, **electrons** from the n-region recombine with **holes** in the p-region at the junction.
- This recombination releases energy in the form of **light**.
- The **color** of the emitted light depends on the materials used (e.g., gallium arsenide for red, gallium phosphide for green).
- LED works only in **forward bias** and does not emit light in reverse bias.

Characteristics:

- **Forward Voltage**: 1V to 3V
- **Forward Current**: 20–100 mA
- **Intensity of light** increases with **forward current**
- Requires a **series resistor** to limit current and avoid damage.



Q14. Explain working of photovoltaic cell with help of diagrams and list its applications. (4/6/8)

Photovoltaic Cell (Solar Cell)

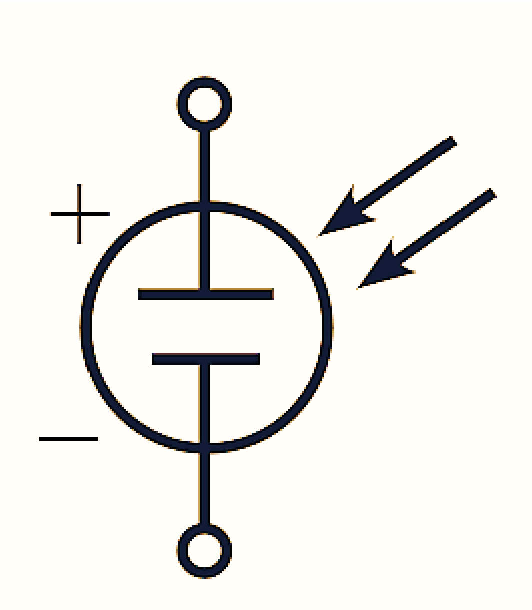
A **photovoltaic cell** (or **solar cell**) is a device that **converts sunlight directly into electrical energy** using the **photovoltaic effect**.

Working:

- It is made of a **pn junction** (usually silicon).
- When **sunlight** falls on the cell, **photons** of light strike the **pn junction**.
- This energy creates **electron-hole pairs**.
- Due to the **electric field** at the junction, electrons move to the **n-side**, and holes to the **p-side**, generating a **potential difference (voltage)**.
- If an **external circuit** is connected, current flows and **electric power** is obtained.

Applications:

1. **Solar panels** for homes and buildings.
2. **Solar calculators and watches.**
3. **Street lighting** and **traffic signals.**
4. **Space satellites** and **remote areas.**
5. Used in **solar-powered chargers** and **vehicles.**



Q15. Explain working of Photo diode with help of diagram and Characteristics. (4/6)

Photo Diode

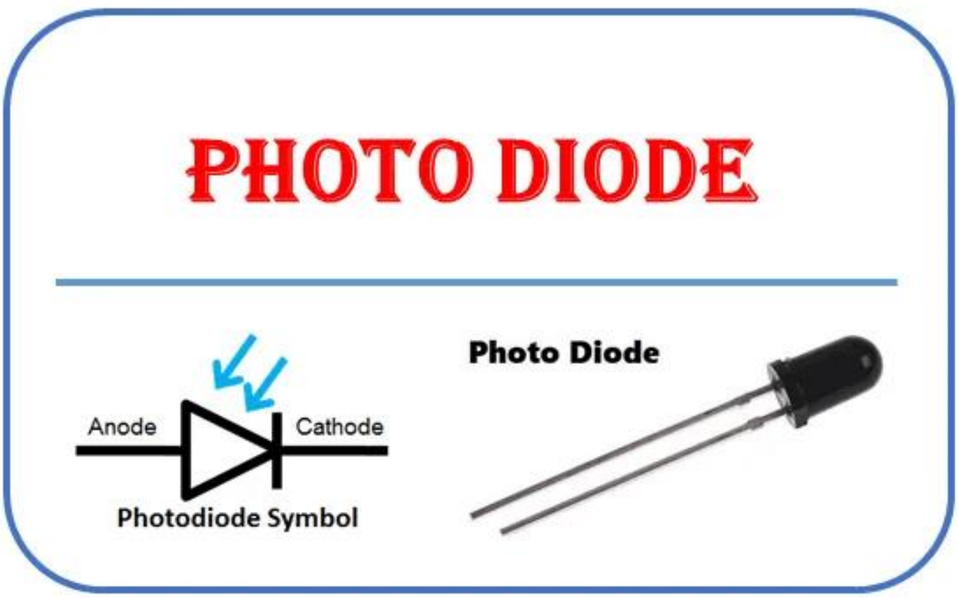
A **Photo-diode** is a **reverse-biased** pn junction diode in which the **reverse current increases with light intensity** falling on the junction.

Working:

- In reverse bias, only a small leakage current flows in a regular diode.
- In a **photo-diode**, when **light (photons)** falls on the **pn junction**, it creates **electron-hole pairs**.
- These charge carriers are swept across the junction by the electric field, increasing **reverse current**.
- The **more the light intensity**, the **greater the reverse current**.
- So, **photo-diodes convert light energy into electrical current** in reverse bias mode.

Characteristics:

- Operates in **reverse bias**.
- **Reverse current ∝ Light intensity**
- Very **fast response** to light.
- Used in **light sensors**, **optical communication**, and **safety systems**.
- Less current in **dark**, more current in **light**.
- Made from materials like **silicon or germanium**.



Unit 3 – Transistors

Q1. Define transistor, draw its symbol, why it is called Transistor? (4)

PAGE NO.:
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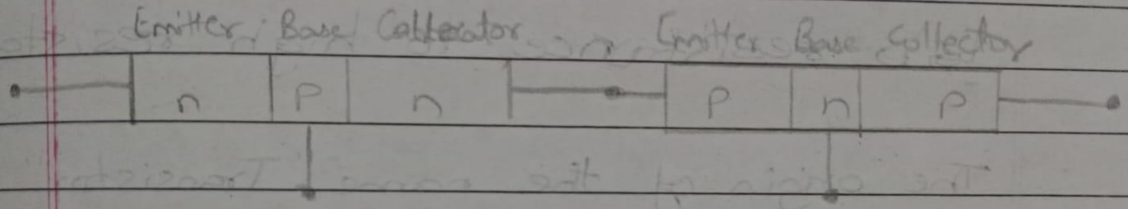
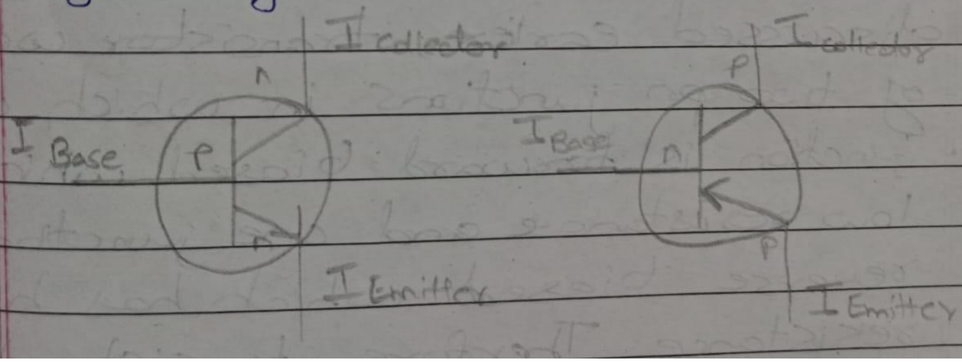
Transistor consists of two pn junction sandwiching either p-type or n-type semiconductor between a pair of opposite types.



Symbol of Transistor :-



The origin of the name "Transistor" comes from the prefix 'Trans' i.e. Transfer and 'istor' i.e. Resistor. As discussed earlier, transistor consists of two pn junctions in which one junction is forward biased which has low resistance and one junction is reverse biased which has high resistance. Therfore, transistor transfers siegnal from low resistance to high resistance.

Q2. Explain with neat diagram the transistor action in NPN or PNP transistor. (6/8)

DATE: / /

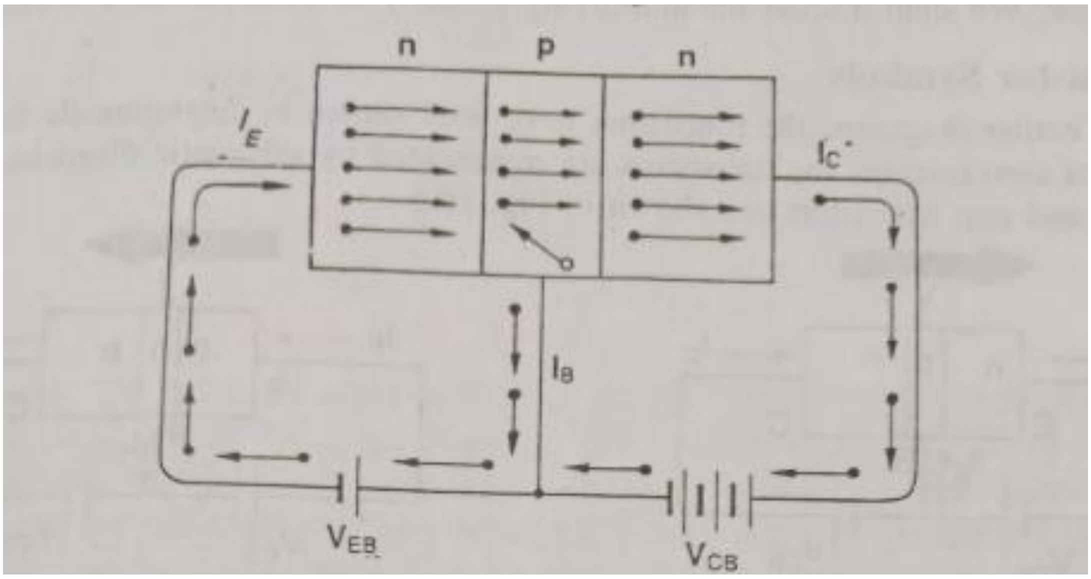
Working of npn transistor :-

1) In npn transistor, emitter-base junction is forward bias and collector-base junction is reverse bias.

2) The forward bias causes the electrons in the n-type emitter to flow towards base. This constitutes the emitter current I_E.

3) As these electrons flow through the p-type base, they tend to combine with holes. As the base is lightly doped and very thin, therefore only a few electrons (less than 5%) combines with holes to constitute base current I_B.

4) The remainder (more than 95%) cross over into the collector region to constitute collector current I_C. In this way almost entire emitter current I_E flows in the collector circuit.



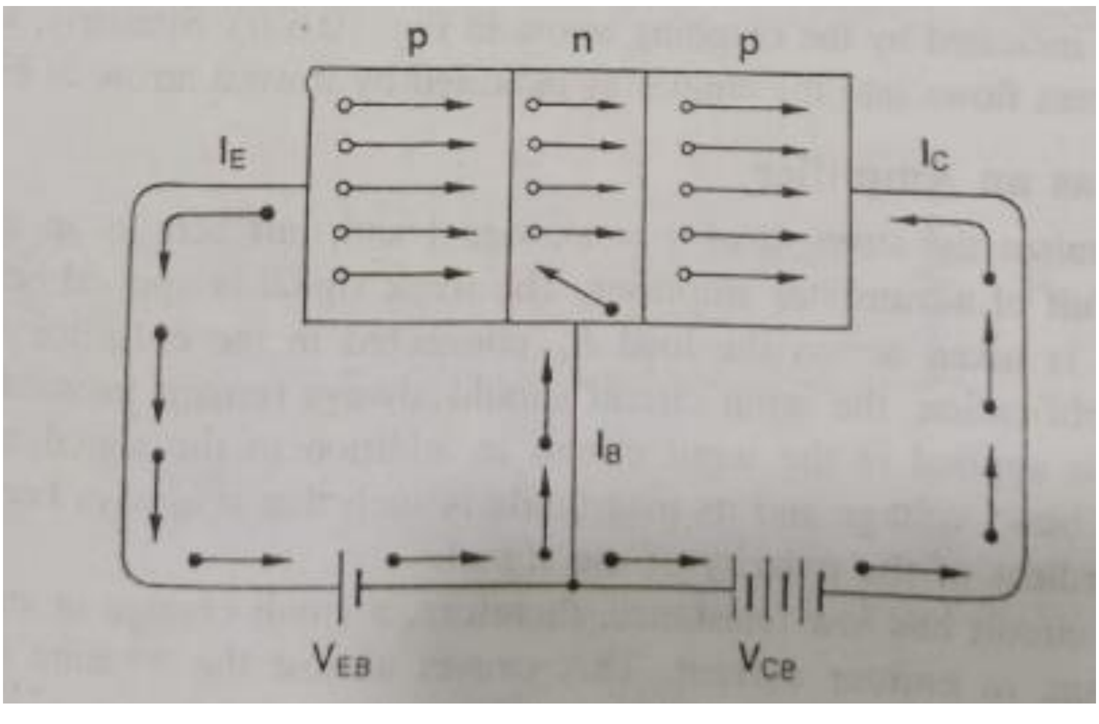
Working of pnp transistor :-

1) In pnp transistor, emitter-base junction is forward bias and collector-base junction is reverse bias.

2) The forward bias cause the holes in the p-type emitter to flow towards base. This constitutes the emitter current I_E

3) As these ~~electrons~~ holes flow through the n-type base, they tend to combine with electrons. As the base is lightly doped and very thin, therefore only a few holes (less than 5%) combines with electrons to constitute base current I_B.

4) The remainder (more than 95%) cross over into the collector region to constitute collector current I_C. In this way almost entire emitter current I_E flows in the collector circuit.



Q3. With neat diagram explain Transistor as an Amplifier. (6/8)

PAGE NO.:

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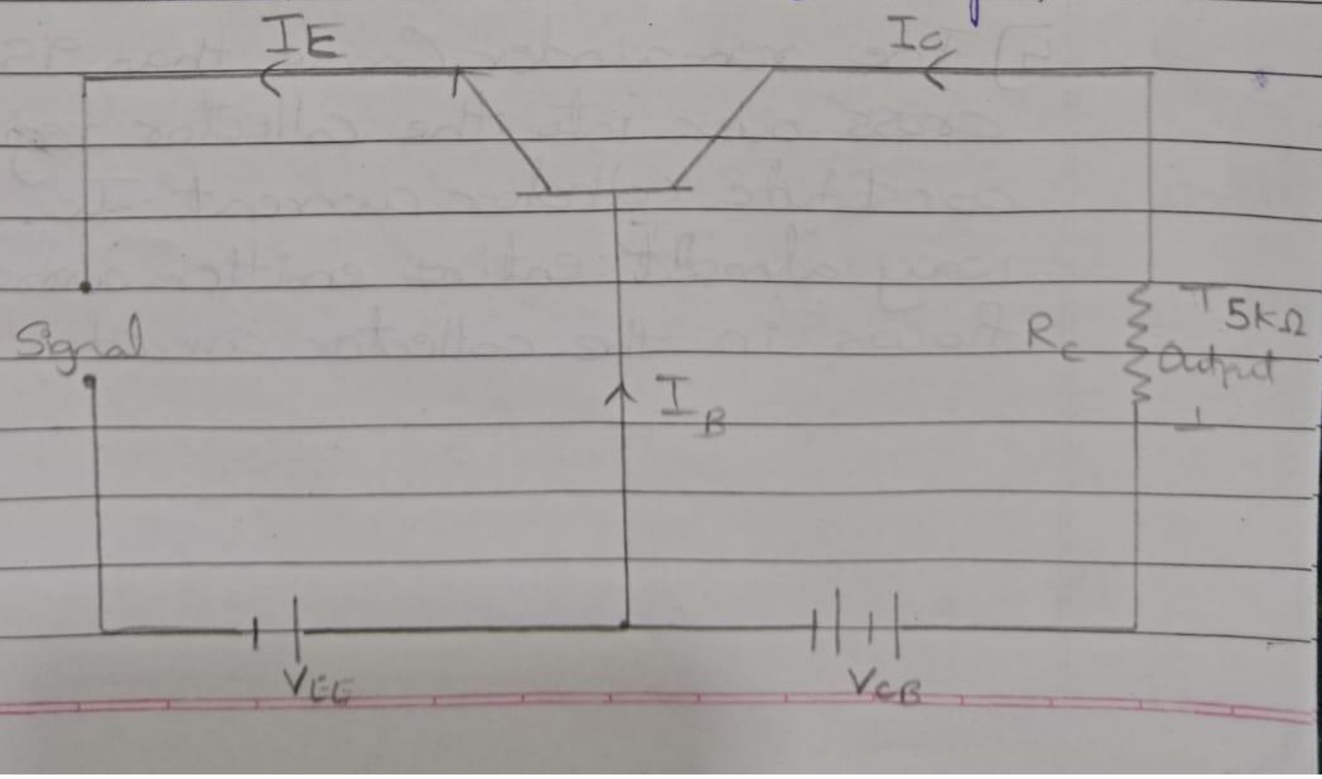
A transistor raises the strength of a weak signal and thus acts as an amplifier. The weak signal is applied between emitter-base junction and output is taken across the load R_C connected in the collector circuit. In order to achieve faithful amplification, the input circuit should always remain forward biased. The collector current flowing through a high resistance R_C (Collector Circuit) produces a large Voltage across it. Thus, a weak signal applied in the input circuit appears in the amplified form in the collector circuit. Thus, a transistor acts as an Amplifier.



Q4. Draw the neat diagram of Transistor common base configuration and define its Current amplification factor. (4/6)

10.8 Common Base Connection

In this circuit arrangement, input is applied between emitter and base and output is ta[ken] from collector and base. Here, base of the transistor is common to both input and output circ[uit]

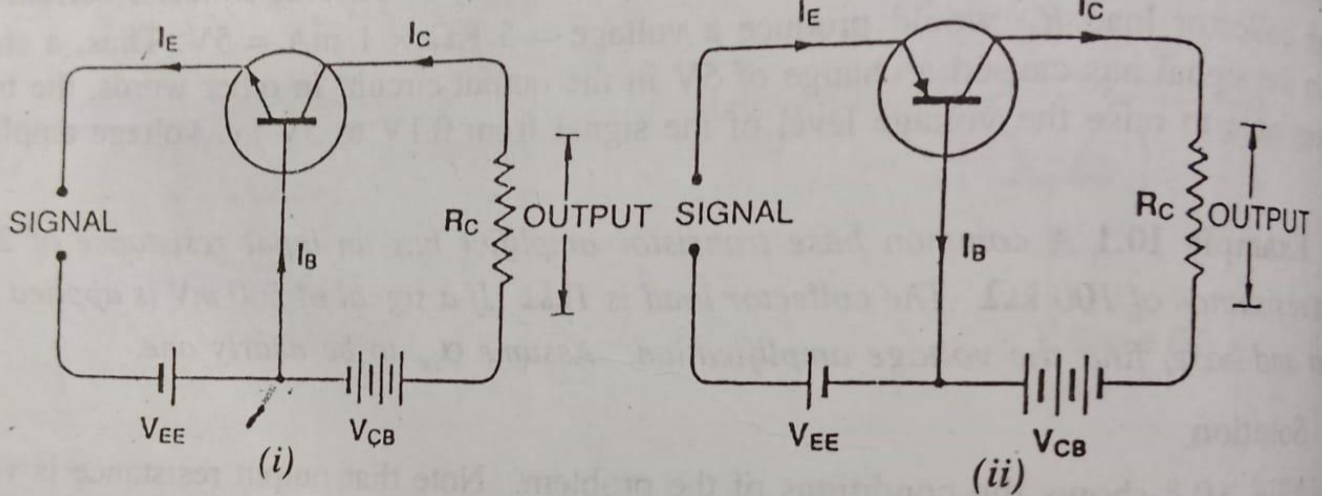


Fig. 10.9

and hence the name common base connection. In Fig. 10.9 (*i*), a common base *npn* transis[tor] circuit is shown whereas Fig. 10.9 (*ii*) shows the common base *pnp* transistor circuit.

1. Current amplification factor (α). It is the ratio of output current to input current. [In] a common base connection, the input current is the emitter current I_E and output current is [the] collector current I_C.

The ratio of change in collector current to the change in emitter current at constant col-lector-base voltage V_{CB} *is known as* **current amplification factor** *i.e.*

$$*\alpha = \frac{\Delta I_C}{\Delta I_E} \text{ at constant } V_{CB}$$

It is clear that current amplification factor is less than **unity. This value can be increa[sed] (but not more than unity) by decreasing the base current. This is achieved by making the b[ase] thin and doping it lightly. Practical values of α in commercial transistors range from 0.9 to 0.[99]

2. Expression for collector current. The whole of emit[ter current does n]ot reach collector. It is because a small percentage of i[...]

Q5. Draw the neat diagram of Transistor common emitter configuration and define its Base Current amplification factor. (4/6)

... change in V_{CB}.

10.10 Common Emitter Connection

In this circuit arrangement, input is applied between base and emitter and output is taken from the collector and emitter. Here, emitter of the transistor is common to both input and output circuits and hence the name common emitter connection. Fig. 10.16 *(i)* shows common emitter npn transistor circuit whereas Fig. 10.16 *(ii)* shows common emitter *pnp* transistor circuit.

1. Base current amplification factor (β). In common emitter connection, input current is I_B and output current is I_C.

The ratio of change in collector current (ΔI_C) to the change in base current (ΔI_B) is known as **base current amplification factor** *i.e.*

$$\beta^* = \frac{\Delta I_C}{\Delta I_B}$$

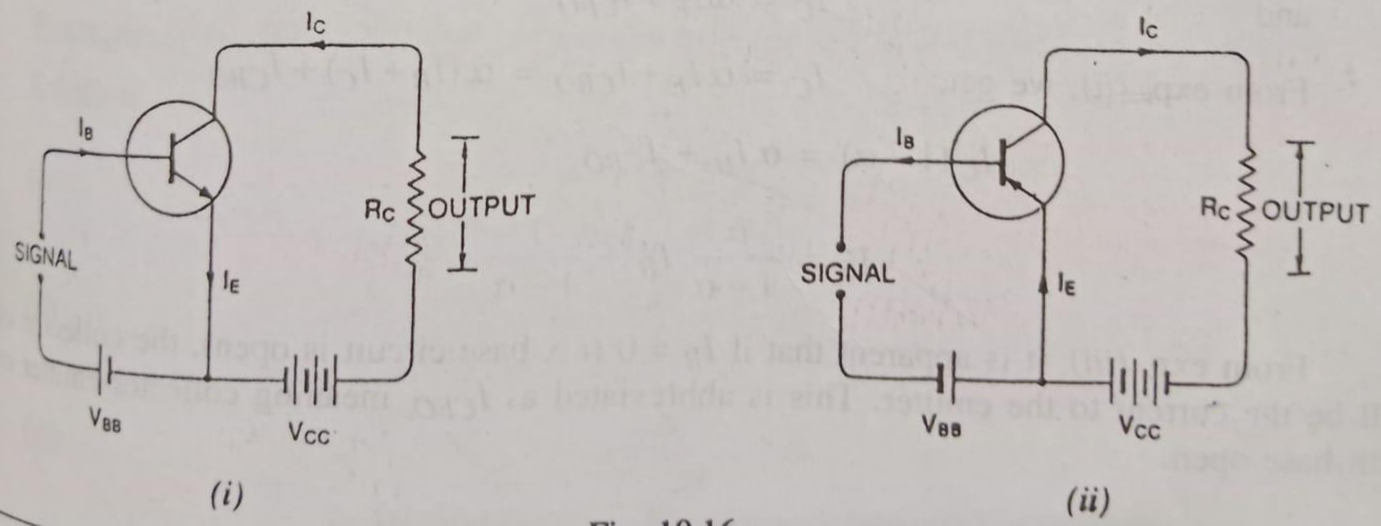


Fig. 10.16

* If d.c. values are considered, $\beta = I_C / I_B$

Q6. Derive the relation between α and β. (4/6)

In almost any ... the value of β is generally greater than 20. ... current gain as well as voltage gain. Thus this type of connection is frequently used as it gives appreciable current gain as well as voltage gain.

Relation between β and α. A simple relation exists between β and α. This can be derived as follows :

$$\beta = \frac{\Delta I_C}{\Delta I_B}$$

$$\alpha = \frac{\Delta I_C}{\Delta I_E}$$

Now,

$$I_E = I_B + I_C$$

or

$$\Delta I_E = \Delta I_B + \Delta I_C$$

or

$$\Delta I_B = \Delta I_E - \Delta I_C$$

Substituting the value of ΔI_B in exp.(*i*), we get,

$$\beta = \frac{\Delta I_C}{\Delta I_E - \Delta I_C}$$

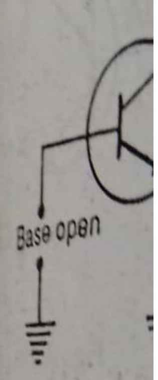
Dividing the numerator and denominator of R.H.S. of exp. (*iii*) by ΔI_E, we get,

$$\beta = \frac{\Delta I_C / \Delta I_E}{\frac{\Delta I_E}{\Delta I_E} - \frac{\Delta I_C}{\Delta I_E}} = \frac{\alpha}{1-\alpha} \qquad \left[\alpha = \frac{\Delta I_C}{\Delta I_E}\right.$$

$\therefore$

$$\beta = \frac{\alpha}{1-\alpha}$$

It is clear that as α approaches unity, β ...



When the base ...